

## Multi-Disk refining at a paper mill



- Energy saving of over 30%
- Payback of five months
- More uniform refined pulp stock
- Higher freeness of pulp
- Substitution of DIP for CTMP



ENERGY EFFICIENCY

## HOST ORGANISATION

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***The Multi-Disk refiner concept was purchased on the belief there would be significant technical advantages compared to conventional double-disc refining, i.e. potential for increasing strength properties with corresponding improvements to sheet porosity and smoothness whilst maintaining bulk. In practice these have been realised.***

***The spin-off energy savings as these sheet properties are developed at higher freeness levels is an attractive bonus, and to some extent we have taken advantage of this by increasing machine speed on Bridgewater PM1.***

***This project has effectively led us to rethink our current refining strategy.***

A handwritten signature in black ink, appearing to read "M.A. Bookbinder".

M.A. Bookbinder, Bridgewater Newsprint

### BRIDGEWATER PAPER COMPANY LIMITED

The Bridgewater Paper Company is a subsidiary of Stone-Consolidated Corporation, an independent Canadian company dedicated to the manufacture of newsprint. Stone-Consolidated Corporation is one of the largest producers of newsprint in the world, producing over 1.4 million tonnes each year.

The Bridgewater Paper Company employs 590 people at its Bridgewater Newsprint Mill in Ellesmere Port. The mill operates three twin-wire machines and is capable of producing over 270,000 tonnes of newsprint each year, in a wide range of grades, colours and sizes.

## BACKGROUND

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A high proportion of recycled fibre is used to make the paper. At the start of this project, the stock composition was approximately 24% imported chemi-thermo-mechanical pulp (CTMP) and 76% de-inked pulp (DIP), comprising 80% newspapers and 20% 'Pams' (printings and magazines). Refined stock from two DIP and two CTMP lines was separately blended to feed each of the three newsprint machines. The DIP was double-refined, which proved beneficial to the finished product and allowed the mill to meet the exacting requirements of lightweight grades of newsprint.

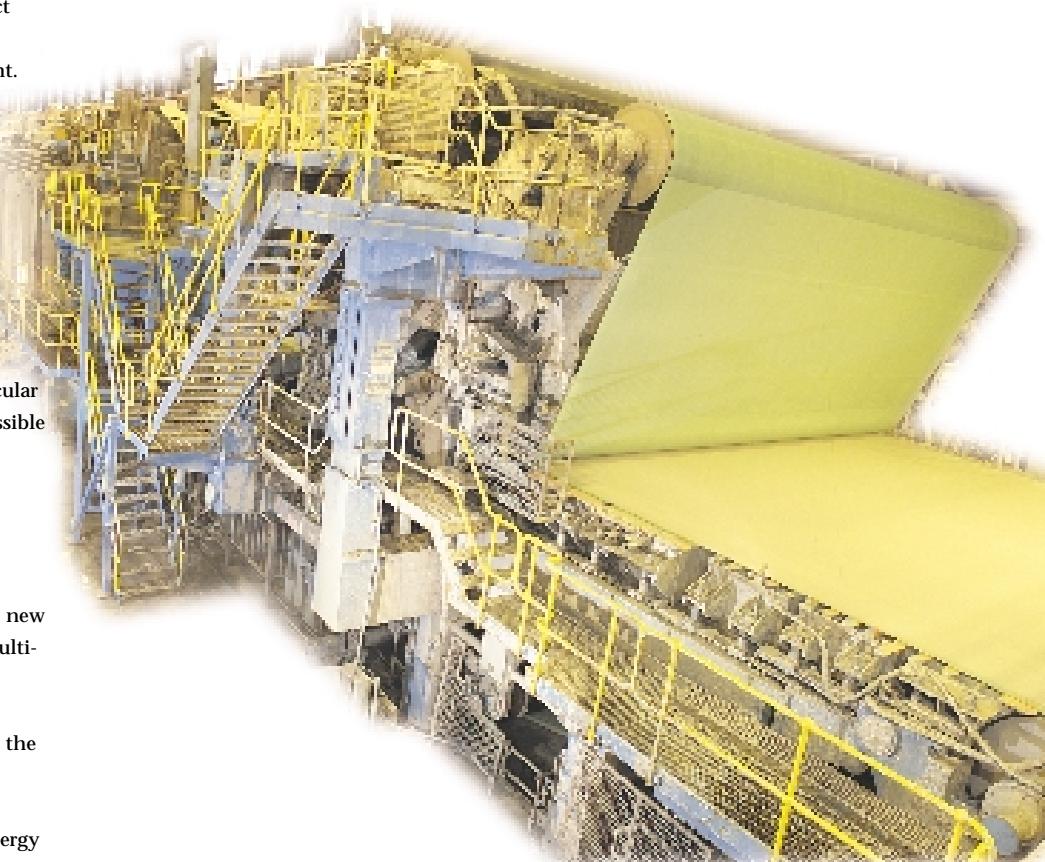
Bridgewater Newsprint Mill decided to install a third DIP line, to allow the use of a higher proportion of recycled material, ultimately up to 95%. At the same time it decided to refine the blended furnish ahead of each paper machine, instead of refining DIP and CTMP separately, enabling:

- furnish treatment to be suited to the particular product being made, thus avoiding the possible over-refining of individual pulps;
- better control of refining at a steady throughput and consistency.

To enable refinement of the blended furnish, a new refiner was needed. The recently developed Multi-Disk refiner was chosen for several reasons:

- Multi-Disk refining is particularly suited to the treatment of short fibres;
- the refiner offered the chance to reduce energy consumption;
- using a single unit to treat the full machine furnish would simplify operations.

The Multi-Disk refiner was installed to refine furnish for the PM1 newsprint machine. PM1 operates at 850 m/min, trims at 6.85 metres and makes approximately 105,000 t/annum of newsprint and directory paper in the 36 to 55 gsm range, some of which is coloured. It is equipped with a Valmet Sym-Flo Jetmatic headbox with automatic slice control, Dynaformer forming section and triple press arrangement.



The project was monitored independently by: Mr G H Nuttall. Tel: 01423 872669  
 The Multi-Disk refiner was supplied by: Beloit Walmsley Limited. Tel: 01204 396060

## THE ORIGINAL STOCK PREPARATION SYSTEM

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Fig 1 shows the stock preparation system for PM1 before installation of the Multi-Disk refiner. DIP from one of two high density towers passed through a double-disc refiner to a chest ready for distribution to any one of the three paper machines. DIP for use on PM1 proceeded through a second double-disc refiner to the blend chest. A separate double-disc refiner was used to refine CTMP, which was then mixed with DIP, broke and recovered fibre in the blend chest. The furnish in the blend chest was used to feed PM1 and also formed the sweetner stock.

A comprehensive system of flowmeters, consistency regulators and control valves enabled remote control of the stock preparation system. In addition, each refiner was equipped with a remote gap setting facility and power use indicator.

Fig 1 Original stock preparation system

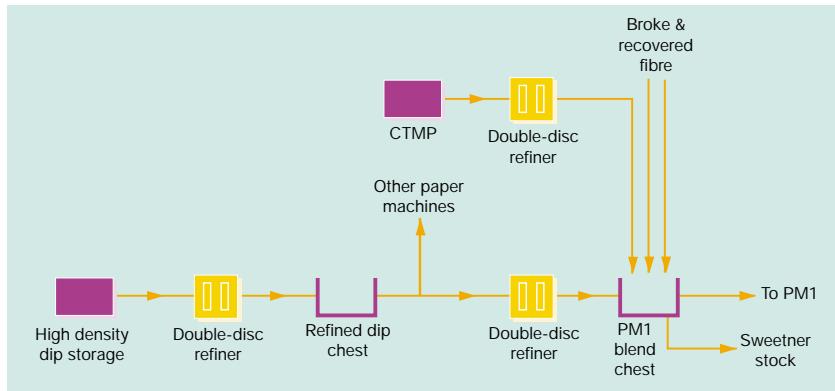
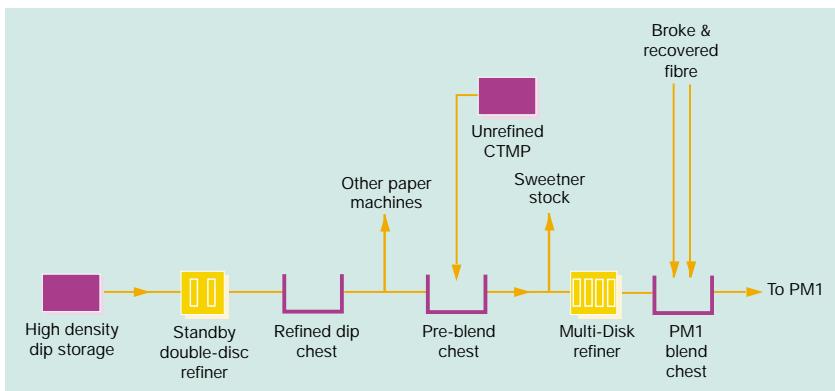


Fig 2 Modified stock preparation system



### THE MODIFIED STOCK PREPARATION SYSTEM

Fig 2 shows the modified stock preparation system, following installation of the Multi-Disk refiner. Unrefined DIP and CTMP are mixed in the pre-blend chest, before passing to the Multi-Disk refiner. The refined blend is mixed with broke and recovered fibre in the blend chest, before being fed to PM1. Sweetner stock is now unrefined, fed from the pre-blend chest. One double-disc refiner was retained on the DIP line in case the Multi-Disk refiner provided insufficient treatment, although it has not been used.

### THE MULTI-DISK REFINER

The Multi-Disk refiner design allows up to three rotating discs to be positioned between stationary discs. All discs are free to move axially to vary the pressure applied to stock passing through the multiple refining interfaces. The refiner installed at Bridgewater Newsprint Mill (Fig 3) contains three 38 inch rotating discs, forming six refining faces in place of the usual two in a double-disc refiner. The unit is equipped with an 800 kW motor and has specific power consumption (kWh/t) control, with a refiner speed of 500 rpm.

Multi-Disk refiners can apply a much lower Specific Edge Load (SEL) than conventional refiner assemblies. Low values of SEL are needed to develop the strength potential of short fibres without excessive cutting and reduction of pulp freeness, which slows drainage and limits paper machine speed.

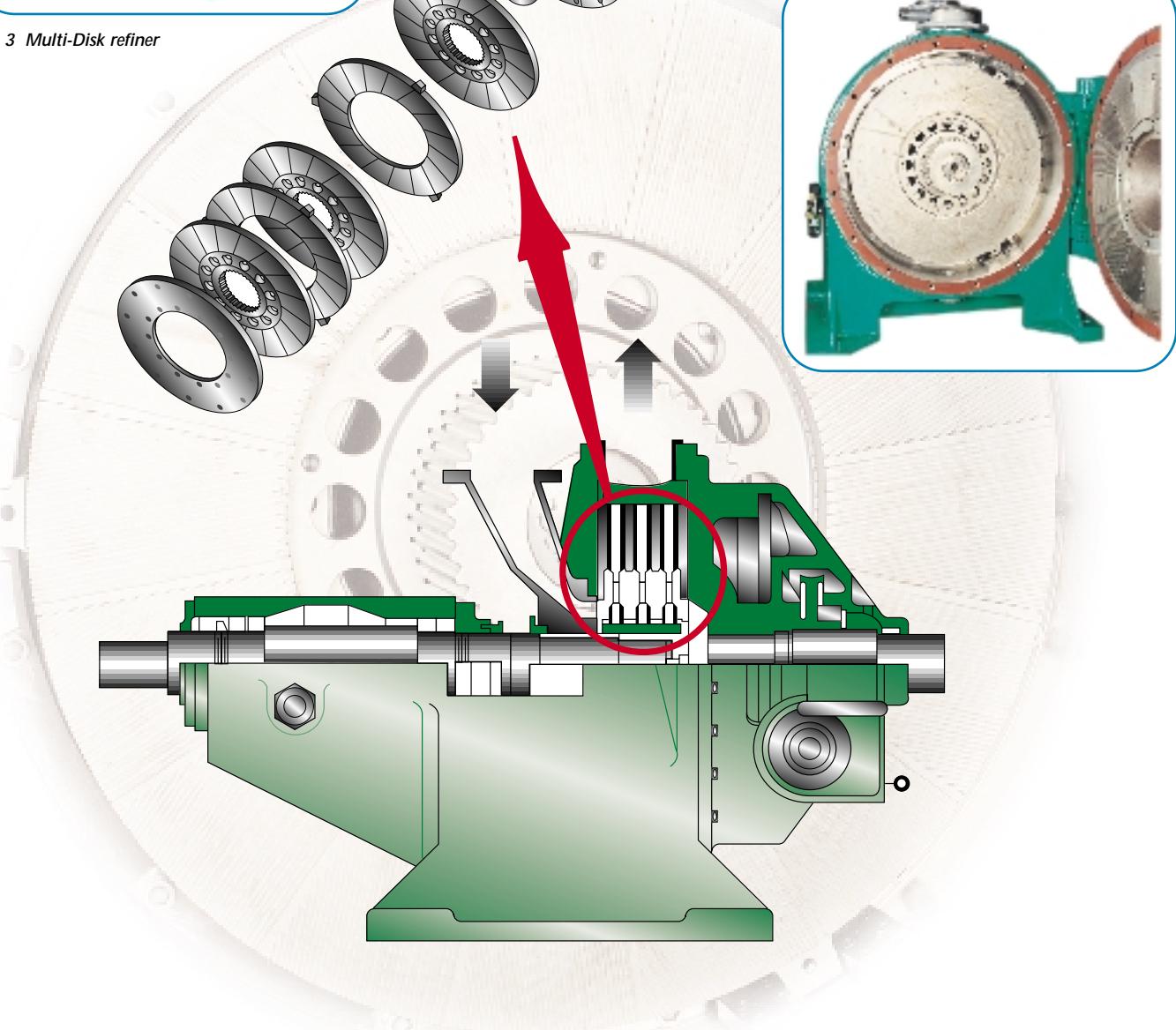
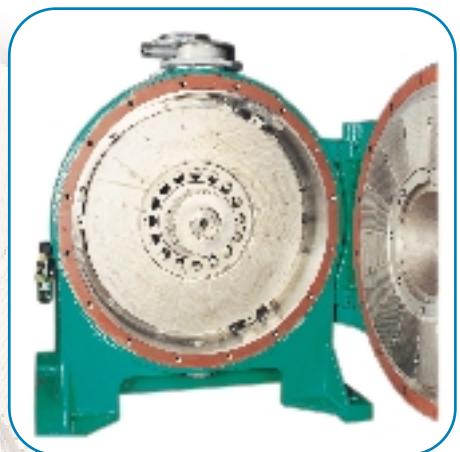
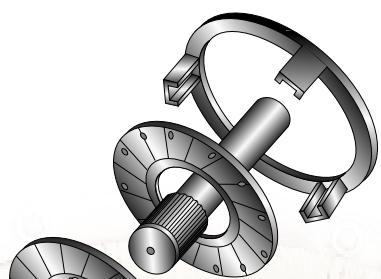
### OPERATIONAL EXPERIENCE

Installation at the Bridgewater Newsprint Mill was completed in January 1996. Problems during the commissioning stage delayed putting the Multi-Disk refiner on stream by about a month. Most of the problems were minor and related to failure of instrumentation associated with the supply to the refiner. The only mechanical problem was a failure of the plate loading gearbox bearing which was promptly replaced. Since commissioning was completed, operation of the unit has been trouble-free.

## THE MULTI-DISK REFINER



Fig 3 Multi-Disk refiner



## MONITORING

### MONITORING

To verify the operation of the Multi-Disk refiner and its impact on paper production, extensive monitoring was carried out:

- Operating conditions when running a tightly-specified grade of 45 gsm newsprint were monitored before and after installation of the Multi-Disk refiner. Measurements were taken on three separate occasions to ensure that results were representative.
- The Fibre Technology Association carried out specific tests on stock samples taken before and after each refiner, to assess the fibre development of both refining methods.
- The performance of PM1 was monitored over a twenty-week period around the installation of the Multi-Disk refiner.

The energy and cost savings are shown in Table 1, and the principal averaged monitoring results are shown in Table 2.

### ENERGY AND COST SAVINGS

Monitoring showed that significant energy and cost savings have been achieved since installation of the Multi-Disk refiner, confirming that the Multi-Disk develops shorter fibres more efficiently. The total energy saving amounts to

64,800 primary GJ per year worth £167,600 or £1.65 per net tonne, based on an annual PM1 output of 105,000 t, although not all of the savings are directly attributable to installation of the Multi-Disk refiner.

### OTHER FACTORS AFFECTING ENERGY USE, MACHINE PERFORMANCE AND STEAM USE

#### *Energy use and machine performance*

When assessing the changes in refining performance, three key changes which took place at the same time as installation of the Multi-Disk refiner must be considered:

- The installation of a third DIP line means that a higher proportion of newsprint can be used in the furnish without affecting product quality, reducing the proportions of 'Pams' and CTMP.
- The CTMP is now refined at the same time as the DIP in the Multi-Disk refiner.
- In the original system (Fig 1), the sweetner stock was fed from the PM1 blend chest, and consisted of refined DIP and CTMP together with broke and recovered fibre. In the new system (Fig 2), the sweetner stock is fed from the pre-blend chest and consists of unrefined DIP and CTMP. This change allows a higher proportion of fibre to be recovered in the disc filter and returned to the main line via the PM1 blend chest. As a result of this change, the rate of virgin fibre requiring refining has been reduced from an average of 10.80 t/h to 8.95 t/h, and the amount of recirculation around the Multi-Disk refiner has increased.

#### *Steam Use*

Steam consumption in the dryers per tonne of paper made has reduced since the Multi-Disk refiner was installed. There are several reasons for this reduction:

- the use of a higher proportion of DIP in the furnish results in a drier stock (CTMP when refined separately is wetter);
- higher output rates;
- Multi-Disk refining results in fibre development with less drop in freeness, resulting in freer draining stock and easier drying of the more bulky fibres.

**Table 1 Energy and cost savings**

Item	Before	After	Annual saving <sup>1</sup>	Annual saving GJ	Annual cost saving <sup>2</sup>
Refining power (kWh/t)	117	82	3,675,000 <sup>3</sup>	13,230	£123,600
Total steam (t/gross t paper)	1.63	1.57	6,300 <sup>4</sup>	19,500 <sup>5</sup>	£44,000
<b>Total annual cost savings</b>					<b>£167,600</b>

*Notes:*

<sup>1</sup> Annual saving based on gross PM1 output of 105,000t/year.

<sup>2</sup> Cost savings based on 1995 energy prices.

<sup>3</sup> Delivered savings in KWh.

<sup>4</sup> Delivered savings in tonnes of steam.

<sup>5</sup> Based on energy savings for gas-fired boilers.

## MONITORING

**Table 2 Monitoring Results**

Parameter	Before	After	Percentage Change
<b>Refiner conditions</b>			
Flow through refiners (t/h) <sup>1</sup>	10.80	8.95	-17
Total power used (kW)	1,265	720	-43
Net power used (kW)	543	280	-48
Total power used (kWh/t)	117	81	-31
Net power used (kWh/t)	50	31	-38
<b>Furnish and general stock conditions</b>			
<b>Furnish</b>			
News (%) <sup>2</sup>	50	63	+26
Pams (%)	28	22	-21
CTMP (%)	22	15	-32
Stock temperature (°C) <sup>3</sup>	57	49	-14
Headbox consistency (%)	0.74	0.73	-
Retention (%)	57.0	57.3	-
<b>Machine conditions</b>			
Broke addition (t/h) <sup>4</sup>	3.72	1.74	-53
Speed (m/min)	832	837	+0.6
Gross output (t/h)	15.4	15.8	+2.6
Vacuum pump (kWh/gross t paper)	29.4	29.7	-
Steam usage (t/gross t paper)	1.46	1.47	-
<b>Machine performance</b>			
Gross production rate (t/h)	14.7	15.1	+2.7
Net production rate (t/h)	13.1	13.4	+2.3
Broke (%)	10.9	11.0	-
Total vacuum pump power (kWh/t)	120	119	-

**Notes:**<sup>1</sup> Sweetner stock re-routed<sup>2</sup> De-inked pulp in the post-installation trials was partly from the newly commissioned third DIP line which is designed to use more recycled newsprint while maintaining quality.<sup>3</sup> Stock temperature in the post-installation trials is lower because the location of the dispersing equipment in the new DIP line is earlier in the system, reducing the overall operation temperature.<sup>4</sup> The percentage of broke being used in the post-installation trials was significantly lower: this does not reflect a long-term change and was due only to the machine conditions at the time.

## CONCLUSIONS

### OTHER BENEFITS OF MULTI-DISK REFINING

Monitoring of machine performance before and after installation of the Multi-Disk refiner showed a small increase in machine output (Table 2), confirmed in the long-term comparative data. The increase is worth some £400,000 per year to Bridgewater Newsprint Mill.

The increase in output is due mainly to the stock being less wet on the wire and therefore easier to dry, enabling higher machine speed. Although some of the stock change is attributable to the use of Multi-Disk refining, freer stock will also result from the change in furnish proportions and using combined refining.

### PAYOUT

Bridgewater Newsprint Mill installed the Multi-Disk refiner as part of a programme to increase the amount of DIP used in its paper production. The costs associated with the installation are shown in Table 3.

Based on energy savings alone (assuming all energy savings are attributable to the Multi-Disk refiner), annual savings of £167,600 give a simple payback of 18 months.

If the financial benefits due to increased output are included, total annual savings amount to £567,600, giving a simple payback of just over five months.

**Table 3 Multi-Disk refiner costs**

Item	Cost
Multi-Disk unit (excluding commissioning)	£225,000
Additional annual maintenance costs <sup>1</sup>	£21,000
<b>Total cost for Multi-Disk refiner unit</b>	<b>£246,000</b>

<sup>1</sup> Due to the higher cost of replacement plates, although plates may be re-cut before completely replacing.

**The Department of the Environment's Energy Efficiency Best Practice Programme** provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. The information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice Programme are shown opposite.

#### Further information

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For industrial and transport topics please contact:  
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**ETSU**  
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Tel 01235 436747  
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E-mail etsuenq@aeat.co.uk

Note: Bridgewater Newsprint Mill installed a completely new unit. The Multi-Disk refiner is housed in the same casing as a conventional double-disc refiner supplied by Beloit Walmsley, making it possible to retrofit Multi-Disk units. Retrofitting would significantly reduce the capital costs and improve the payback period.

### CONCLUSIONS

#### FTA Conclusions

The Fibre Technology Association (FTA) were commissioned to investigate the effects of Multi-Disk refining upon the final product properties. Based on the results of their tests they drew the following conclusions:

- Installation of the Multi-Disk refiner has resulted in pulp producing handsheets with enhanced bulk, air permeability and smoothness relative to the original two-stage double-disc system.
- Although the Multi-Disk refiner does not appear to develop fibre strength properties as effectively as the two-stage double-disc system, this is due to the different fibre furnish used since its installation and the use of combined refining. Although fibre strength appears to have reduced, it is still well within the required specification.
- A more uniform refined pulp stock is produced with the Multi-Disk refiner.
- The Multi-Disk refiner produces a satisfactory pulp at higher freeness with the potential for increased machine speed.

#### General

Based on the experience of this installation, the Multi-Disk refiner appears to offer significant benefits in terms of reduced energy usage and production of a pulp of higher freeness to achieve similar short fibre development. The technique is appropriate to all short fibre pulps requiring relatively light treatment, notably recycled and hardwood.

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**Good Practice:** promotes proven energy efficient techniques through Guides and Case Studies.

**New Practice:** monitors first commercial applications of new energy efficiency measures.

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**Fuel Efficiency Booklets:** give detailed information on specific technologies and techniques.

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